Bureau of Land Management - Alaska Open File Report 10

BLM/AK/OF-85/10 BLM-Alaska Open File Report 10
March 1985

Effects of Fire on a Dwarf Shrub-Sedge Tussock Community in Interior Alaska

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Alaska

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BACKGROUND

In 1977 the Bear Creek Fire burned approximately 142,000 hectares. It burned with differing severities and intensities, and burned many vegetation types. Since the area was accessible via the FAA airstrip at Farewell, BLM managers and resource specialists realized that the Bear Creek Burn provided an excellent opportunity to study the affects of fire on natural resources in Interior Alaska. This is the seventh report on fire effects.

OBJECTIVES

The immediate, short-term objective of this study is to determine the extent of recovery of a dwarf shrub-sedge tussock plant community after fire. Our long-term objectives in this area are to monitor ecological succession and recovery of vegetation after fire, to evaluate the effects of caribou grazing on winter ranges, and to determine how the Bear Creek fire affects caribou distribution. The sampling results reported in this paper are to be used as baseline data to meet the long-term objectives.

STUDY AREA

The Bear Creek study area is located between the Windy and South Forks of the Kuskokwim River, west of the Alaska Range in Interior Alaska. Much of this area burned in a 142,000 hectare wildfire in 1977. The nearest settlement is Farewell, which is located 8 km (5 miles) southeast of the sites selected for vegetation sampling and monitoring (figure 1).

The climate is typical of Interior Alaska with long, cold winters and short, cool summers. The mean daily maximum and minimum temperatures for Farewell are 18 degrees Centigrade (C) and 7.2 degrees C in July and -13 degrees C and -24 degrees C in January. Extreme temperatures vary from 32 degrees C to -51 degrees C.

Annual precipitation at Farewell is 42 cm with 29 cm occurring from May through August. Annual snowfall is 141 cm. Due to the almost constant winds off the Alaska Range, snow accumulations are usually less than 51 cm in open areas. The study sites have topography typical of the surrounding area, which is best described as a glacial, depositional proglacial outwash plain. There is less than 5% slope, with a northwest aspect. The soils are comprised of poorly drained silty material with a thick organic mat underlain by permafrost (Reiger, et. al. 1979).

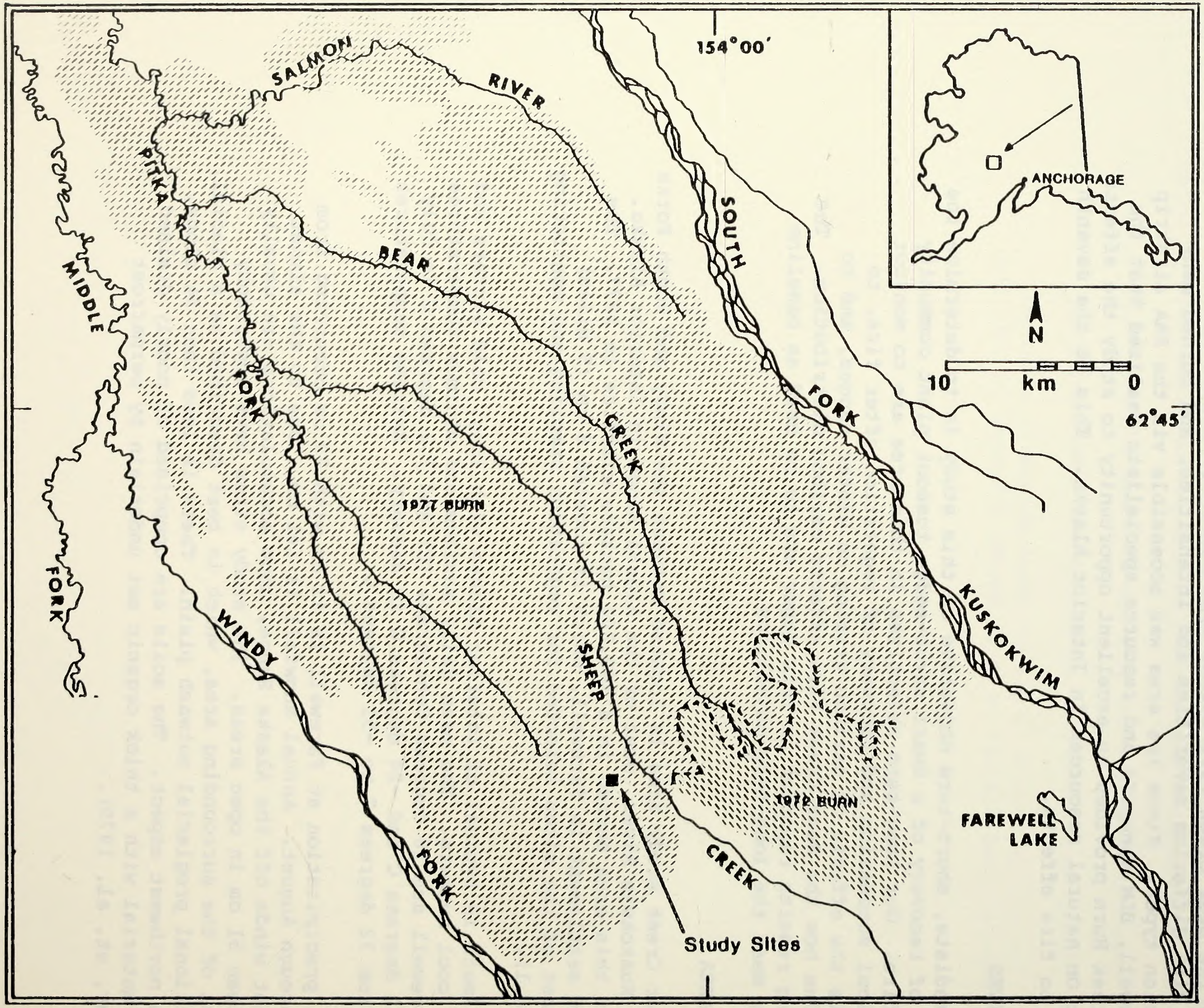

Fig. 1. The Bear Creek Study Area, Alaska

The pre-fire community in the area sampled was described as a Labrador tea-blueberry/cloudberry-sedge tussock community (Hanson, 1979). Various dwarf shrubs dominate this community and a few scattered, stunted black spruce are interspersed throughout. This community is usually found between drainages intergrading into a black spruce/feather moss community (Hanson, 1979). Descriptions of surrounding communities and a history of the Bear Creek Fire are available (Hanson, 1979).

Most of the wildlife species found in Interior Alaska occur on the study area. The Bureau of Land Management (BLM) and the Alaska Department of Fish and Game (ADF&G) have been monitoring the use of the burn by bison, caribou, and moose and monitoring their distribution on the burn since 1979; caribou use of the study area is evident.

METHODS

Four 25 m x 25 m sites were selected (figure 1) for sampling vegetation. Inspection of pre-burn Landsat images and field examination indicated that all four sites were of the same vegetation type before the 1977 fire. Two of the sites burned in 1977 and two were in adjacent unburned "islands." The vegetation sampling plots that had burned were estimated by Hanson (1983) to have burned at low intensity during the Bear Creek Fire of 1977.

Half of each site was reserved for future studies, leaving a 12.5 m x 25 m area for the vegetation sampling in this study. The sampling area was divided into four rows (2 m wide), and five permanent plots (60 cm x 40 cm) were established at 5 m intervals along each row. A 1 m wide walkway was established between every other row to assure that observers did not disturb the study plots. Each walkway was marked by placing three evenly spaced metal rods (90 cm x 1.6 cm) on both sides. Each plot was marked with a steel rod (30 cm x 0.95 cm). Figure 2 illustrates the sampling design.

A 100-point frame was constructed to determine the relative amount of basal and foliar cover in the plots (figure 3). A metal rod was passed through the frame at an angle of approximately 10 degrees so that 100 equally spaced points would be struck by the rod. Basically this is ten repetitions of a ten-point frame (Hays, et. al., 1981). All foliar hits were recorded by species except those passing through sedges or grasses. Only basal hits were recorded for grasses and sedges. Total foliar cover and the foliar cover species of grasses and sedges were also estimated to the nearest 5% ocularly. Basal hits were recorded by species or substrate if no live plants were present.

An oblique 35 mm color photograph was taken of each odd-numbered plot with the photographer standing approximately 0.6 m from the western boundary of the plot. Two oblique photographs were also taken from each corner of each site--one from 1.5 m and one from 3 m away from each corner. These photographs are held at the BLM's Anchorage District Office.

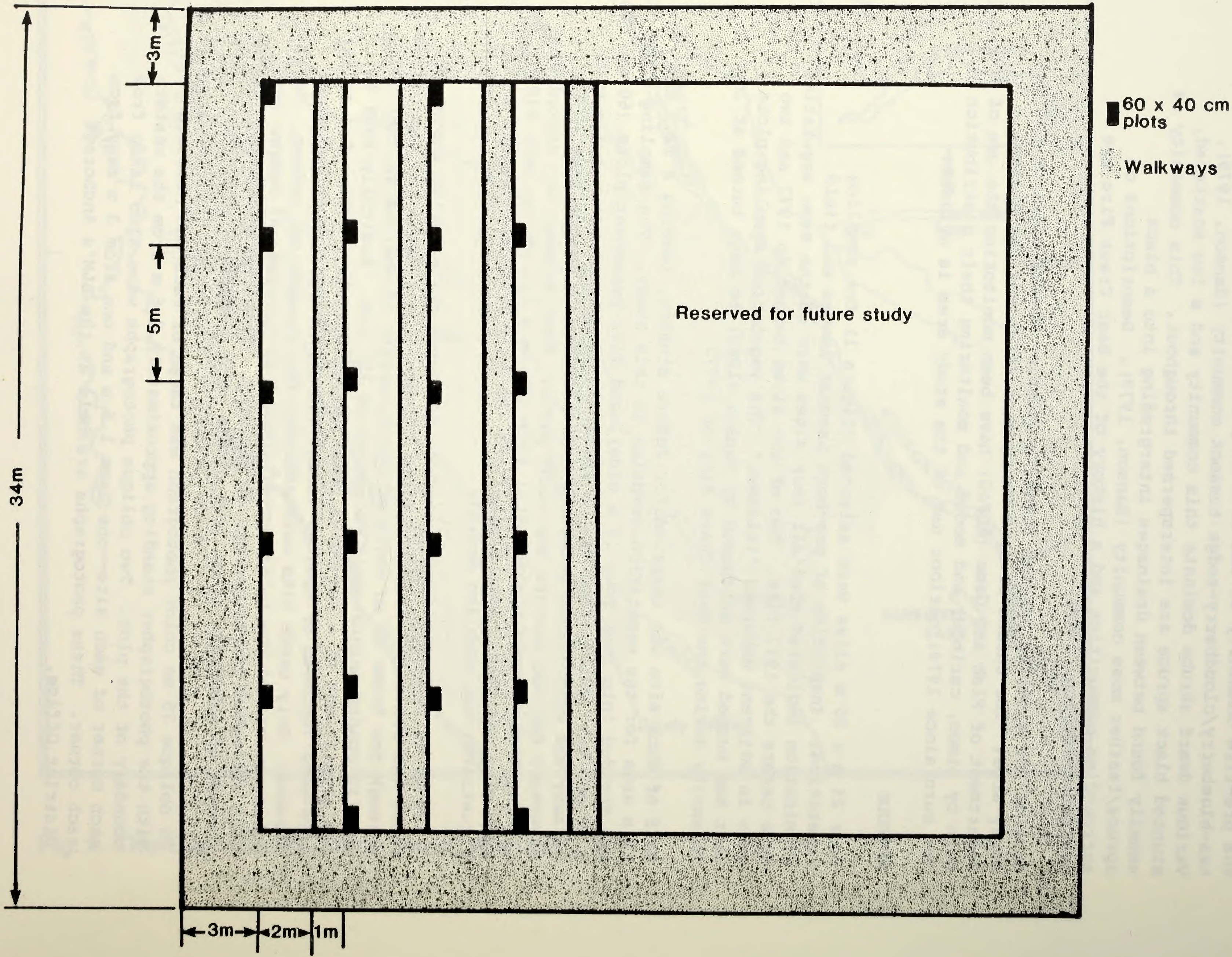

Figure 2. Plot & Sampling Design

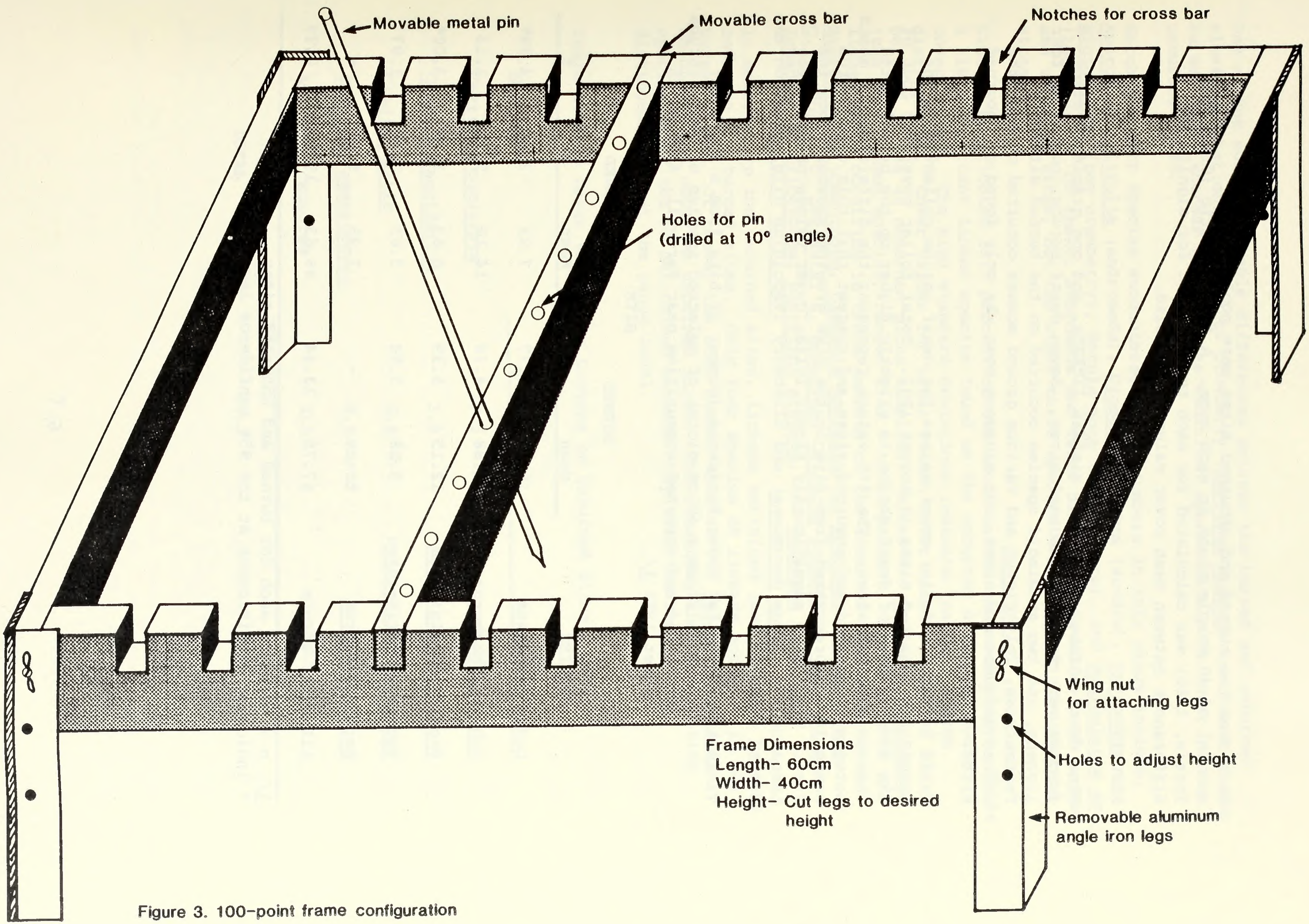

Figure 3. 100-point frame configuration

Data from the burned and unburned sites were pooled for a total of 40 sample plots in each type. A "t" statistic (Steel and Torrie, 1960) was calculated for each type to test for significant differences between mean cover values of species.

RESULTS

Nine dwarf shrubs, two herbs, sixteen lichens, and one graminoid plant species were found in unburned sites. Seven dwarf shrubs, no herbs, four lichens, and two graminoid species occurred on the burned sites. Feathermoss, _Polytrichum_ and various ground mosses occurred on both the burned and unburned sites, but sphagnum moss was only found on unburned sites.

Table 1 displays foliar cover values for dwarf shrubs collected on the burned and unburned sites in August 1982. Total foliar cover for four of the five species of dwarf shrubs is slightly higher on the burned sites than on unburned sites. The "t" values represent the differences in means between the burned and unburned sites and suggest that this dwarf shrub community has recovered from fire in the five growing seasons since the fire. There were significantly higher foliar cover values obtained for Labrador tea (_Ledum decumbens_) and blueberry (_Vaccinium uliginosum_) on the burned sites.

Table 1. Mean Foliar Cover Estimates (Number of hits from a 100-point frame in 20 cm x 40 cm plots) of selected species of dwarf shrubs on burned and unburned communities near Farewell, Alaska, in August 1982 1/

	SITE				
	BURNED		UNBURNED		
SPECIES	Mean	s	Mean	s	t
Ledum decumbens	15.33	8.77	7.93	3.84	4.89*
Rubus chamaemorus	12.88	4.78	14.10	5.51	1.13
Vaccinium uliginosum	12.15	6.39	8.63	3.79	3.00*
Vaccinium vitis-idaea	5.08	3.94	3.63	2.49	1.97
Empetrum nigrum	trace	-	7.95	5.46	-
All dwarf shrubs	47.75	13.44	46.63	13.04	0.29

1/. n = 40 plots each for burned and unburned sites.
* indicates significance at the 95% confidence level.

One of the most noticeable differences between the burned and unburned sites was that only a trace of crowberry (Empetrum nigrum) was found in the burned site, whereas this species exhibited approximately 8% cover in the unburned sites.

Shrub and herb species encountered in low numbers in this study include: Andromeda polifolia (andromeda), Drosera angelica (sundew), Oxycoccus microcarpus (bog cranberry), Betula nana (dwarf birch), and Pedicularis sp (lousewort). Of these, andromeda and dwarf birch were found on both burned and unburned sites, but the other three species only occurred in unburned sites.

Lichens contributed 19.3 percent of the cover on the unburned plots. Table 2 lists important lichen species found on the unburned sites and their cover values. The high standard deviations indicate "patchy" lichen distribution. Cover values for total lichen cover ranged from 0 to 53 percent in the 40 unburned plots sampled. Values for Cetraria cucullata (the most common species) ranged from 0 to 27 percent. Other species of lichen found occurring in trace amounts on the unburned sites include: Stereocaulon tomentosum, Cladonia uncialis, C. gracilis, C. coccifera, C. crispata, C. pyxidata, C. ecmocyna, Cetraria islandica, C. nivalis, Icmadophila ericetorum, Dactylina arctica, and Nephroma arcticum.

In contrast to the unburned sites, lichens exhibited less than one percent cover on the burned sites. Only four species of lichens appeared in the burned sites. Of these, the most common species was Peltigera malacea which did not occur on unburned sites. The remaining three colonizing species could not be determined because they were too small to be distinguishable at the genus level.

Table 2. Mean Cover Values for Lichens on Unburned Sites. (N=40)

SPECIES	% COVER	s
Cetraria cucullata	10.5	7.77
Cladina rangiferina	3.0	3.90
Cladina mitis	3.8	4.27
Cladonia amaurocraea	0.9	1.33
All other species	1.1	2.65
TOTAL	19.3	

Total foliar cover based on ocular estimates was 96.1 percent (s = 4.14) on unburned sites and consisted of a variety of dwarf shrub, lichen, and graminoid cover. This was significantly higher at the 95% confidence level (t = 8.77 with 39 degrees of freedom) than the 76.8 percent (s = 13.43) vegetation cover on burned sites. Most of the vegetation cover on burned was contributed by Eriophorum augustifolium (cotton grass).

Basal cover estimates for the burned and unburned sites are presented in Table 3. Forty-five percent of the basal cover was sphagnum on the unburned sites, but the burned sites contained none. However, small colonizing mosses, as well as Polytrichum and feather mosses (ie., Hylochomnium and Splendens), were found on some unburned sites. Other significant differences include a higher amount of litter and cotton grass basal cover on burned sites. The 11.1 percent basal cover listed as "other" in Table 3 consisted mostly of basal hits in lichen mats.

Table 3. Basal Cover Estimates on Burned and Unburned Sites 1/.

	SITE				
	BURNED		UNBURNED		
SPECIES	Mean	s	Mean	s	t
Litter	68.8	10.14	23.0	16.62	14.87*
Moss	5.1	4.00	63.5	24.78	14.71*
Eriophorum augustifolium	26.0	10.41	2.4	2.41	13.91*
Other	1.1	-	11.1	-	-
TOTAL	100.0%		100.0%		

1/. N = 40 plots each for both burned and unburned sites.

DISCUSSION

Effects of Fire on Dwarf Shrub Communities

The dwarf shrub community that was sampled is recovering from the 1977 fire. In 1982, cover values appear to be increasing for most dwarf shrub species on burned sites. Incorporation of Hanson's 1978 and 1980 data with our data shows the trends of dwarf shrub recover after fire (Table 4). All species listed in the table, except cloudberry (Rubus chamemorus) have shown a dramatic increase over the pre-burn state within three years after the fire. Crowberry was completely eliminated from burned sites and has not reestablished itself five years later. Racine (1981) and Viereck (1973) reported similar effects on dwarf shrub communities following fire. Since crowberry plants are considered to be highly flammable fuels (Sylvester and Wein, 1981), this may reduce the likelihood of individual plants surviving a fire.

Table 4. Trends in % Cover of Dwarf Shrubs on a Burned Tundra Community and Comparison with nearby Unburned Communities.

Species	Burned 1978*	Burned 1980**	Burned*** 1982	Unburned*** 1982
	PERCENT COVER			
Ledum decumbens	6	13	15	8
Vaccinium uliginousun	2	9	12	8
Vaccinium vitas-idaea	2	-	5	3
Rubis chamaemorus	2	8	13	14

* Hanson (1979)
** Hanson (1980)
*** Our data

Racine (1981) and Viereck and Schandelmeir (1980) have also found blueberry, cranberry (Vaccinium vitis-idaea) and Labrador tea can show dramatic increases after fire. We speculate as mosses and other species begin to invade spaces between the cotton grass tussocks, soils become cooler and retain water more readily. The cool, wet soils inhibit growth and nutrient intake by these species, which may reduce shrub viability over time.

We observed cloudberry plants growing on moss beds and tussocks rather than between them. Perhaps this microhabitat allows cloudberry to continue a relatively high productivity long after burning. Cloudberry root systems may be protected from fire by the insulation of the moss hummocks.

Effects of Fire on Lichens

Rowe and Scotter (1973) characterize the post-fire lichen recovery in three general stages: (1) colonization by crustose lichens that bind soil; (2) dominance of fast growing but small Cladonia species; and (3) replacement of these colonizing species by slow growing Cladina lichens. The number of years in each time period varies with the dominant species and geographic location, but Rowe and Scotter feel that Ahti's (1959) time scale for Newfoundland correctly describes the general sequence occurring after a fairly severe fire. Ahti delineates a Cladonia (horn lichen) phase between 10 and 30 years post-fire; a first reindeer lichen phase dominated by Cladina mitis, C. rangiferina, and C. uncialis between 30 and 80 years after fire; and a second reindeer lichen phase beginning after 80 years, which is dominated by Cladina alpestris (Cladina stellaris). Kershaw and Rouse (1976) stated that generalization, should not be made.

There has been almost no recovery of lichens from the Bear Creek Fire. This could be consistent with the 10 to 30 year development phase described above.

Effects of Fire on Mosses

Sphagnum moss is absent from the burned sites and apparently did not survive the fire. Ground mosses and feather moss have started to reestablish since the 1977 fire.

Effects of Fire on Eriophorum

Cotton grass showed dramatic increases in cover after the fire. Foliar cover was 12, 31 (Hanson, 1983), and 40 percent at one, three, and five years after the fire, respectively; whereas, three percent cover was observed in unburned areas. The basal area of Eriophorum tussocks also increased after the fire. Five years after burning, tussocks represent 26 percent of the basal cover on burned sites, but only 2.5 percent on unburned sites. We attribute this to two factors: more of the tussock can be seen after a fire due to removal of the thick sphagnum and lichen mat on and between tussocks, and the tussock's increase in size during the vigorous vegetative growth after burning.

Effects of Fire on Caribou

On the burned sites, the fire consumed nearly all of the lichens, an important component of caribou winter diet. However, unburned inclusions on the burned area have been used by caribou during winter on the burn since 1979 (Hinkes, 1979). Hinkes reported that the diet of animals feeding within the burn was composed of 60 to 77 percent lichens. Our observations and observations by others familiar with the burn area and the caribou population concur that this fire has had little impact on caribou. We believe this is due to two factors: the fire burned in such a manner that many unburned islands were left, and the caribou herd was far below the range's carrying capacity at the time of the burn. Because the study area is utilized by caribou, the exclosures should enable us to evaluate the effects of grazing subsequent to fire.

Literature Cited

Ahti, T. 1959. Studies of the caribou lichen stands of Newfoundland. Journal of Ann. Soc. Bot. 30(4):1-44.

Hanson, William A. 1979. Preliminary results of the Bear Creek fire effects studies. Anchorage District Office open file report. USDI, Bureau of Land Management, available at Anchorage District Office Permanent Files.

Hanson, William A. (In press). Early revegetation of the Bear Creek Burn in Interior Alaska. Alaska State Office, USDI, BLM. ASO Techincal Note.

Hinkes, Michael T. 1979. Bear Creek burn winter reconnaissance report. Anchorage District Office Open file report. USDI, BLM, 9p and appendices.

Kershaw, K. A. and W.R. Rouse. 1976. The impact of fire on forest and tundra ecosystems. Final report 1975. Arctic Land Use Res. Program, Dept. Indian Affairs and North. Develop. ALUC Rept. 75-76-63. 54p.

Racine, C.H. 1981. Tundra fire effects on soils and three plant communities along a hill-slope gradient in the Seward Peninsula, Alaska. Artic, 34(1): 71-84

Rieger, S., Schoephorster, D.B., and Furbush. 1979. Exploratory soil survey of Alaska. USDA, Soil Conservation Service. 213 p. and 29 maps.

Rowe. J. S., and G.W. Scotter. 1973 Fire in the boreal forest. Quat. Res. 3(3): 444-464.

Steel, R. G. D. and J.H. Torrie. <u>Principles and Procedures of Statistics</u>. McGraw-Hill Book Co., N.Y. 471 p.

Sylvester, T. W. and R. W. Wein. 1981. Fuel characteristics of Arctic plant species and simulated plant community flammability by Rothermel's model. Canadian Journal of Bot. 59:898-907.

Viereck, L.A. 1973. Forest ecology of the Alaska taiga. Proceedings of Circumpolar Conf. on Northern Ecology. September, 1973. Ottawa Ont., Canada. USDA, Forest Service. 22p.

Viereck, L. A. and Schandelmeir. 1980. Effects of fire in Alaska and adjacent Canada--a literature review. BLM-Alaska Technical Report 6. 124p. Available from NTIS. PB 81-115438.